Abstract No. Rave0209

EXAFS and Neutron Diffraction Study of the Heusler Alloy Co2MnSi

B. Ravel (NRL), M. P. Raphael (NRL), V. G. Harris (NRL), Q. Huang (NIST)

Beamline(s): X23B and X23A2

Introduction: Spintronic devices, devices which rely upon the spin of the conduction electron to control device properties, are of increasing scientific and commercial interest. These devices are commonly heterostructures with ferromagnetic metals used as spin-injectors. The performance of these heterostructured devices can be optimized by using a 100% spin polarized ferromagnet. Recent band structure calculations predict that the Heusler alloy Co_2MnSi should be a 100% spin polarized ferromagnet. However band structure calculations further suggest that chemical disorder in the Co_2MnSi lattice should lower the degree of spin polarization. In this work, we present neutron diffraction and extended x-ray-absorption fine-structure measurements (EXAFS) on bulk Co_2MnSi which reveal extensive chemical disordering even in pure-phase samples and discuss the limitations of EXAFS in measuring this sort of disorder..

Methods and Materials: Polycrystalline {\cms} was prepared by arc-melting stoichiometric quantities of Co, Mn and Si. Boules were broken apart and ground in an agate mortar to prepare samples for EXAFS measurements in the transmission geometry. Transmission EXAFS was performed at the National Synchrotron Light Source at beamlines X23b and X23a2. Data were measured on each sample at four temperatures between 10 K and 300 K.

Conclusions: We have measured the antisite disordering in the bulk material under the assumption that it is the cause of the suppressed spin polarization in Co_2MnSi. In the long term we will investigate the relation between structural disorder and spin polarization in film samples with the goal of determining whether Co_2MnSi is indeed a good candidate for use in spin-polarized electronics. Although neutron diffraction proved to be more sensitive to the antisite disordering than EXAFS, it is not a suitable technique for investigation of thin film samples. Because of the limited diffracting volume, the count rate from film samples in a neutron diffraction experiment would be prohibitively low. EXAFS, however, is easily measured on thin films. The current study, therefore, serves a very useful purpose. We now have a basis from which to understand future EXAFS measurements on Co_2MnSi films. Furthermore, we now know the extent of the structural information available in the Co_2MnSi EXAFS spectrum and the limitations on measuring anti-site disorder in Co_2MnSi.

Acknowledgments: We thank B. Das and E. Carpenter for help in sample preparation and J. Kirkland and J. Woicik for assistance in data collection. BR was a fellow of the American Society of Electrical Engineers and MPR was a fellow of the National Research Council. This work was supported in part by DARPA.